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SCIENCE 14

This program of studies for Science 14 is to be provincially implemented in the 2002–2003 school year. Provincial implementation of Science 24 will occur in September 2003. Prior to September 2003, this program will be reissued as part of the Science 14–24 Program of Studies.

PROGRAM RATIONALE AND PHILOSOPHY

Students graduating from Alberta schools require the scientific and related technological knowledge and skills that will enable them to understand and interpret their world and become productive members of society. They also need to develop attitudes that will motivate them to use their knowledge and skills in a responsible manner. Science programs provide opportunities for students to develop knowledge, skills and attitudes that they need to explore interests and prepare for further education and careers.

To become scientifically literate, students must develop a thorough knowledge of science and its relationship to technologies and society. They must also develop the broad-based skills needed to identify and analyze problems; explore and test solutions; and seek, interpret and evaluate information. To ensure that programs are relevant to students as well as societal needs, a science program must present science in meaningful context—providing opportunities for students to explore the process of science, its applications and implications, and to examine related technological problems and issues. By doing so, students

become aware of the role of science in responding to social and cultural change and in meeting needs for a sustainable environment, economy and society.

Program Vision

The secondary science program is guided by the vision that all students have the opportunity to develop scientific literacy. The goal of scientific literacy is to develop the science-related knowledge, skills and attitudes that students need to solve problems and make decisions, and at the same time help them become lifelong learners—maintaining their sense of wonder about the world around them.

Diverse learning experiences within the science program provide students with opportunities to explore, analyze and appreciate the interrelationships among science, technology, society and the environment, and develop understandings that will affect their personal lives, their careers and their futures.

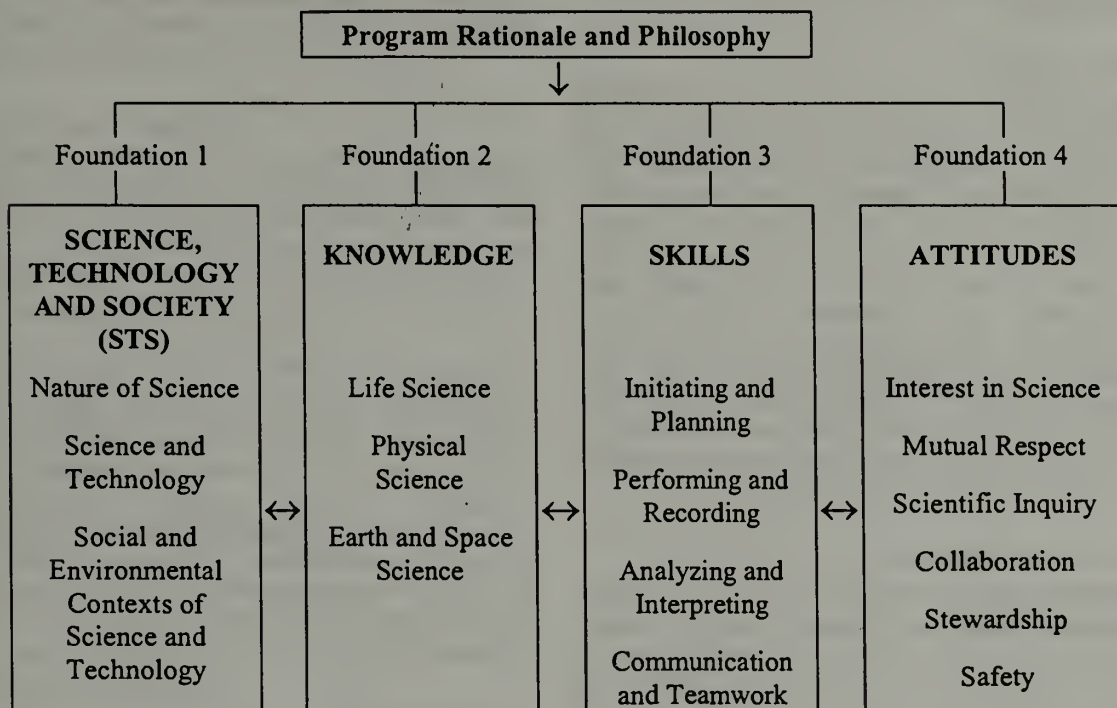
Goals

The following goals for Canadian science education are addressed through the Alberta science program. Science education will:

- encourage students at all grade levels to develop a critical sense of wonder and curiosity about scientific and technological endeavours
- enable students to use science and technology to acquire new knowledge and solve problems, so that they may improve the quality of their own lives and the lives of others
- prepare students to critically address science-related societal, economic, ethical and environmental issues
- provide students with a foundation in science that creates opportunities for them to pursue progressively higher levels of study, prepares them for science-related occupations, and engages them in science-related hobbies appropriate to their interests and abilities
- enable students, of varying aptitudes and interests, to develop a knowledge of the wide spectrum of careers related to science, technology and the environment.

PROGRAM FOUNDATIONS

To support the development of science literacy, school programs must provide a foundation of learning experiences that address critical aspects of science and its application. These critical areas—the foundations of the program—provide general direction for the program and identify major components of its structure.



Foundation 1

Science, Technology and Society (STS)—*Students will* develop an understanding of the nature of science and technology, the relationships between science and technology, and the social and environmental contexts of science and technology.

Foundation 2

Knowledge—*Students will* construct knowledge and understandings of concepts in life science, physical science and Earth and space science, and apply these understandings to interpret, integrate and extend their knowledge.

Foundation 3

Skills—*Students will* develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively and for making informed decisions.

Foundation 4

Attitudes—*Students will be encouraged to* develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society and the environment.

Foundation 1: Science, Technology and Society (STS)

Foundation 1 is concerned with understanding the scope and character of science, its connections to technology, and the social context in which it is developed. The following is a brief introduction to the major ideas that underlie this component of the program.

Nature of Science

Science provides an ordered way of learning about the nature of things, based on observation and evidence. Through science, we explore our environment, gather knowledge and develop ideas that help us interpret and explain what we see. Scientific activity provides a conceptual and theoretical base that is used in predicting, interpreting and explaining natural and technological phenomena. Science is driven by a combination of specific knowledge, theory and experimentation. Science-based ideas are continually being tested, modified and improved as new knowledge and explanations supersede existing knowledge and explanations.

Science and Technology

Technology is concerned with solving practical problems that arise from human needs. Historically, the development of technology has been strongly linked to the development of science, with each making contributions to the other. While there are important relationships and interdependencies, there are also important differences. Where the focus of science is on the development and verification of knowledge, in technology the focus is on the development of solutions, involving devices and systems that meet a given need within the constraints of the problem. The test of science knowledge is that it helps us explain, interpret and predict; the test of technology is that it works—it enables us to achieve a given purpose.

Social and Environmental Contexts of Science and Technology

The history of science shows that scientific development takes place within a social context. Many examples can be used to show that cultural and intellectual traditions have influenced the focus and methodologies of science, and that science in turn has influenced the wider world of ideas.

Today, research is often driven by societal and environmental needs and issues. As technological solutions have emerged from previous research, many of the new technologies have given rise to complex social and environmental issues. Increasingly, these issues are becoming part of the political agenda. The potential of science to inform and empower decision making by individuals, communities and society is a central role of scientific literacy in a democratic society.

Foundation 2: Knowledge

Foundation 2 focuses on the subject matter of science, including the theories, models, concepts and principles that are essential to an understanding of each science area. For organizational purposes, this foundation is framed using widely accepted science disciplines.

Life Science

Life science deals with the growth and interactions of life forms within their environments in ways that reflect their uniqueness, diversity, genetic continuity and changing nature. Life science includes such fields of study as ecosystems, biological diversity, the study of organisms, the study of the cell, biochemistry, genetic engineering and biotechnology.

Physical Science

Physical science, which encompasses chemistry and physics, deals with matter, energy and forces. Matter has structure, and there are interactions among its components. Energy links matter to gravitational, electromagnetic and nuclear forces in the universe. The conservation laws of mass and energy, momentum and charge, are addressed in physical science.

Earth and Space Science

Earth and space science brings global and universal perspectives to student knowledge. Earth, our home planet, exhibits form, structure and patterns of change, as does our surrounding solar system and the physical universe beyond it. Earth and space science includes such fields of study as geology, meteorology and astronomy.

Foundation 3: Skills

Foundation 3 is concerned with the skills that students develop in answering questions, solving problems and making decisions. While these skills are not unique to science, they play an important role in the development of scientific understandings and in the application of science and technology to new situations. Four broad skill areas are outlined in this program of studies.

Initiating and Planning

These are the skills of questioning, identifying problems and developing preliminary ideas and plans.

Performing and Recording

These are the skills of carrying out a plan of action that involves gathering evidence by observation and, in most cases, manipulating materials and equipment.

Analyzing and Interpreting

These are the skills of examining information and evidence; processing and presenting data so that it can be interpreted; and interpreting, evaluating and applying the results.

Communication and Teamwork

In science, as in other areas, communication skills are essential at every stage where ideas are being developed, tested, interpreted, debated and agreed upon. Teamwork skills are also important, as the development and application of science ideas is a collaborative process both in society and in the classroom.

Foundation 4: Attitudes

Foundation 4 is concerned with generalized aspects of behaviour—commonly referred to as attitudes. Attitude outcomes are of a different form than outcomes for skills and knowledge; they are exhibited in a different way, and they have deeper roots in the experiences that students bring to school. Attitude development is a

lifelong process that involves the home, the school, the community and society at large. Attitudes are best shown not by the events of a particular moment but by the pattern of behaviours over time. Development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and creating a readiness for responsible application of what is learned.

Interest in Science

Students will be encouraged to develop enthusiasm and continuing interest in the study of science.

Mutual Respect

Students will be encouraged to appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds.

Scientific Inquiry

Students will be encouraged to develop attitudes that support active inquiry, problem solving and decision making.

Collaboration

Students will be encouraged to develop attitudes that support collaborative activity.

Stewardship

Students will be encouraged to develop responsibility in the application of science and technology in relation to society and the natural environment.

Safety

Students will be encouraged to demonstrate a concern for safety in science and technology contexts.

PROGRAM ORGANIZATION AND FORMAT

The Science 14 Program of Studies is organized into units as outlined below.

Unit A	Investigating Properties of Matter
Unit B	Understanding Energy Transfer Technologies
Unit C	Investigating Matter and Energy in Living Systems
Unit D	Investigating Matter and Energy in the Environment

Unit Organization

In Science 14, four units of study are outlined. Each unit includes the following components.

Unit Overview

Each unit of study begins with an overview that introduces the contents of the unit and suggests an approach to its development.

Focusing Questions

These questions frame a context for introducing the unit and suggest a focus for investigative activities and application of ideas by students.

Key Concepts

Key concepts identify major ideas to be developed in each unit. Some of the key concepts may be addressed in additional units of the same course, as well as at other grade/course levels. The intended scope of treatment of these concepts is indicated by the outcomes.

Outcomes

Two levels of outcomes are provided in this program of studies.

- **General Outcomes:** These are the major outcomes for each unit. For Foundations 1 and 2 (STS and knowledge), the outcomes are combined and unique to each unit. For Foundation 3 (skills) and Foundation 4

(attitudes), the outcomes are common to all units.

- **Specific Outcomes:** These are detailed outcomes that flesh out the scope of each unit. They are shown in bulleted form.

Examples

Many of the outcomes are supported by examples. The examples **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed. Illustrative examples are written in *italics* and are separated from the outcomes by being placed in parentheses.

Unit Emphases

Each unit of study begins with an overview and a set of focusing questions that identify a context for study. In defining the context, one of the following areas of emphasis is identified for each unit.

- **Nature of Science Emphasis:** In these units, student attention is focused on the processes by which scientific knowledge is developed and tested, and on the nature of the scientific knowledge itself. The skills emphasized in these units are the skills of scientific inquiry.
- **Science and Technology Emphasis:** In these units, students seek solutions to practical problems by developing and testing prototypes, products and techniques to meet a given need. The skills emphasized are those of problem solving, in combination with the skills of scientific inquiry.
- **Social and Environmental Emphasis:** In these units, student attention is focused on issues and decisions relating to how science and technology are applied. Skill emphasis is on the use of research and inquiry skills to inform the decision-making process; students seek and analyze information and consider a variety of perspectives.

Developing a Nature of Science Emphasis (Grades 10–12)

The following concepts and skills are developed through this program emphasis.

Concepts

- The goal of science is knowledge about the natural world.
- Scientific knowledge and theories develop through hypotheses, collection of evidence through experimentation and the ability to provide explanations.
- Scientific knowledge results from peer review and replication of the research of others.
- Scientific knowledge is subject to change as new evidence comes to light and as laws and theories are tested and subsequently restricted, revised or reinforced.
- The process of scientific investigation includes:
 - identifying the theoretical basis of the investigation
 - clearly defining and delimiting research questions or ideas to be tested
 - designing the investigation
 - evaluating and selecting means to collect and record evidence
 - analyzing the evidence, and providing explanations based upon scientific theories and concepts.
- Scientific paradigms are conceptual inventions that help organize, interpret and explain findings.
 - Concepts, models and theories are often used in interpreting and explaining observations, and in predicting future observations.
 - Conventions of mathematics, nomenclature and notation provide a basis for organizing and communicating scientific theory, relationships and concepts; e.g., chemical symbols.
 - Scientific language is precise, and specific terms may be used in each field of study.
- Scientific inquiry is limited to certain questions.

Skills (focus on scientific inquiry)

Initiating and Planning; e.g.,

- identify questions to investigate
- define and delimit questions to facilitate investigation

- state a prediction and a hypothesis based on available evidence, background information or theory
- evaluate and select appropriate procedures and instruments for collecting evidence and information, including appropriate sampling procedures.

Performing and Recording; e.g.,

- carry out procedures, controlling the major variables, and adapt or extend procedures, if needed
- use appropriate instruments effectively and accurately for collecting data
- select and collect information from various print and electronic sources
- organize and integrate data, using a format that is appropriate to the task or experiment
- select and use apparatus safely, and apply Workplace Hazardous Materials Information System (WHMIS) standards to handle and dispose of materials.

Analyzing and Interpreting; e.g.,

- compile and display findings by hand or computer, using a variety of formats
- interpret patterns and trends in data, and infer and calculate linear and nonlinear relationships among the variables
- predict the value of a variable, by interpolating or extrapolating from graphical data or from a line of best fit
- identify and explain sources of error; and evaluate the relevance, reliability and adequacy of data and data collection methods
- state a conclusion, based on experimental data; and explain how evidence gathered supports or refutes a hypothesis, prediction or theory.

Communication and Teamwork; e.g.,

- work cooperatively with team members to develop and carry out a plan and troubleshoot problems as they arise
- select and use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate findings and conclusions
- evaluate individual and group processes used in planning and carrying out investigative tasks.

Developing a Science and Technology Emphasis (Grades 10–12)

The following concepts and skills are developed through this program emphasis.

Concepts

- The goal of technology is to provide solutions to practical problems.
- Technological development may involve creation of prototypes and testing, as well as application of knowledge from related scientific and interdisciplinary fields.
- Technological problems often lend themselves to multiple solutions, involving different designs, materials and processes, and have intended and unintended consequences.
- Scientific knowledge may lead to the development of new technologies, and new technologies may lead to scientific discovery.
- The process for technological development includes:
 - defining and delimiting clearly the problems to be solved, and establishing criteria to assess the technological solution
 - identifying the constraints and trade-offs
 - developing designs and prototypes
 - testing and evaluating designs and prototypes on the basis of established criteria.
- The products of technology are devices, systems and processes that meet given needs; however, these products cannot solve all problems.
- The appropriateness, risks and benefits of technologies need to be assessed for each potential application from a variety of perspectives, including sustainability.

Skills (focus on problem solving)

Initiating and Planning; e.g.,

- define practical problems
- identify questions to investigate arising from practical problems
- assess and propose alternative solutions to a given practical problem, select one and develop a plan
- evaluate and select appropriate procedures and instruments for collecting data and information and for solving problems.

Performing and Recording; e.g.,

- research and synthesize information relevant to a given problem, using various print and electronic sources
- construct and test a prototype device or system, and troubleshoot problems as they arise
- select and use tools and apparatus safely.

Analyzing and Interpreting; e.g.,

- identify and troubleshoot problems, and refine the operation of prototype devices
- evaluate designs and prototypes on the basis of self-developed criteria; e.g., function, reliability, safety, efficient use of materials, impact on the environment
- identify and evaluate potential applications of findings
- identify new questions and problems that arise from what was learned.

Communication and Teamwork; e.g.,

- work cooperatively with team members to develop and carry out a plan and troubleshoot problems as they arise
- assess and recommend an approach to solving a given problem, based on findings of investigations
- evaluate individual and group processes used in planning and carrying out problem-solving tasks.

Developing a Social and Environmental Emphasis (Grades 10–12)

The following concepts and skills are developed through this program emphasis.

Concepts

- Science and technology are developed to meet societal needs and expand human capability.
- Science and technology are influenced and supported by society and have influenced, and been influenced by, historical development and societal needs.
- Science and technology have both intended and unintended consequences for humans and the environment.
- Society provides direction for scientific and technological development.
 - Canadian society supports scientific research and technological development that helps achieve a sustainable society, economy and environment.
 - Decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations.
 - Society supports scientific and technological development by recognizing accomplishments, publishing and disseminating results, and providing financial support.
- Scientific and technological activity may arise from, and give rise to, such personal and social values as accuracy, honesty, perseverance, tolerance, open-mindedness, critical-mindedness, creativity and curiosity.
- Science and technology provide opportunities for a diversity of careers based on post-secondary studies, for the pursuit of hobbies and interests, and for lifelong learning.

Skills (focus on research and inquiry skills to inform the decision-making process)

Initiating and Planning; e.g.,

- identify science-related issues
- identify questions to investigate arising from science- and technology-related issues
- assess and develop appropriate procedures and instruments for collecting relevant data and information.

Performing and Recording; e.g.,

- research and synthesize information relevant to a given question, problem or issue
- identify data and information that are relevant to the issue from various print and electronic sources
- select and integrate information from various print and electronic sources, or from several parts of the same source.

Analyzing and Interpreting; e.g.,

- apply given criteria for evaluating evidence and sources of information
- apply a variety of perspectives in assessing the risks and benefits of scientific and technological developments
- identify new questions and problems that arise from what was learned
- identify and evaluate potential applications of findings from a variety of scientific, technological and environmental perspectives.

Communication and Teamwork; e.g.,

- work cooperatively with team members to develop and carry out a plan and troubleshoot problems as they arise
- assess potential decisions; and recommend the best decision, based on findings
- make clear and logical arguments to defend a given decision on an issue, based on findings
- evaluate individual and group processes used in investigating an issue and in evaluating alternative decisions.

Unit A: Investigating Properties of Matter (Nature of Science Emphasis)

Overview: The safe handling of chemicals, whether in the home or in the workplace, requires an understanding of the properties of pure substances and mixtures. Students will actively investigate the properties of a variety of samples of matter, including mixtures and solutions, elements, and compounds encountered in everyday life. The atom as the basic building block of matter is introduced. Students also investigate the classification of elements on the periodic table.

Focusing Questions: How do we use properties to classify matter? How can an understanding of the properties of matter be used practically? What is the underlying structure of matter that helps us to classify and understand matter?

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade/course levels. The intended level and scope of treatment is defined by the outcomes below.

- safe handling, storage and disposal of household chemicals
- Workplace Hazardous Materials Information System (WHMIS) and consumer product symbols
- solutions and solubility of household substances
- dilution and concentration
- preparing solutions
- separating mixtures
- acids and bases
- the periodic table: metals, nonmetals and metalloids
- elements and compounds
- corrosion and rusting

Outcomes for Science, Technology and Society (STS) and Knowledge

Students will:

1. Classify various forms of matter, including commonly used household substances, on the basis of their properties, and relate these properties to their safe use, storage and disposal
 - describe the need for safety precautions that should be followed when handling, storing and disposing of substances at home and in the laboratory; and explain the WHMIS and consumer product symbols for labelling substances (*e.g., flammable, corrosive, reactive, health hazard*) [related to learnings/applications in CTS course LGS2030: Environmental Law]
 - describe the importance of mixtures and solutions in household products (*e.g., baking soda, soaps, paints*)
 - compare and contrast the properties of pure substances and mixtures (*e.g., brass and zinc, stainless steel and iron, acetic acid and vinegar, pure water and salt water*), and relate this information to practical applications (*e.g., salting icy roads, adding antifreeze to car radiators*)
 - outline the steps in separating the components of mechanical mixtures and solutions on the basis of their properties (*e.g., filtration of mechanical mixtures, distillation of solutions such as crude oil*)
 - differentiate between physical and chemical properties of matter
 - apply the particle model of matter to explain the physical properties of the phases of matter

2. Describe solutions and solubility, solutes and solvents; and then describe how these concepts are applied to the production of prepared foods and other useful materials
- provide examples of insoluble and soluble mixtures (*e.g., oil and water, vinegar and water*); and, in general terms, account for the difference
 - define, operationally, solute, solvent, solution and solubility; and express concentration in terms of mass per volume [**Prerequisite Skill: Grade 8 Mathematics, Number, Specific Outcome 12; Related Skill: Mathematics 14, Number, Specific Outcome 11**]
 - provide examples of the effect of temperature change on solubility, and explain this effect on the basis of the particle model of matter (*e.g., concentration of brines for pickling and syrups for canning*) [**related to learnings/applications in CTS course FOD3110: Food Processing**]
 - link concentration changes and the concept of dilution to changes in the ratio of the amount of solute to the amount of solvent (*e.g., investigate how concentrated products, such as orange juice, evaporated milk or instant coffee are made*) [**related to learnings/applications in CTS course AGR2050: Agrifoods 1 (Materials & Processes)**]
 - compare the volume of waste packaging produced from consumer use of the concentrated and diluted forms of products (*e.g., orange juice, fabric softener*), and relate this to the need for recycling and environmental preservation [**related to learnings/applications in CTS course ENM1090: Fundamentals of Recycling**]
 - identify acid and base solutions in the home, job site and laboratory (*e.g., vinegar, soda pop, shampoo, battery acid, household ammonia, antacids, dish soap, hydrochloric acid, sodium hydroxide*) on the basis of their general properties; i.e., they conduct electricity, change colour of acid/base indicators and neutralize one another
 - describe, in general terms, the pH scale as an indicator of acidity or basicity; i.e., a pH of less than 7 indicates an acid, a pH of 7 indicates a neutral solution, and a pH of greater than 7 indicates a base
 - describe and investigate the corrosive effects of the following environmental factors: acids, bases, salts, humidity and temperature (*e.g., corrosion of iron by acid rain and spray from ocean water*)
 - list the potential dangers of mixing common household and industrial chemicals (*e.g., mixing ammonia cleaners with bleach, adding muriatic [hydrochloric] acid to caustic soda, adding water to acid*)
3. Describe the properties of elements and compounds, and use the periodic table to identify trends in properties
- differentiate among metals, nonmetals and metalloids on the basis of properties (*e.g., luster, conductivity, malleability, brittleness, state of matter*)
 - use the periodic table to locate names and properties of elements
 - name and write chemical formulas for common elements (*e.g., aluminum, copper, iron, nitrogen, hydrogen, oxygen*) and simple compounds (*e.g., water, glucose, table salt, carbon dioxide, iron oxide, vinegar, methane, propane*), and describe the uses of elements and compounds in society
 - demonstrate the difference between elements and compounds on the basis of a decomposition reaction (*e.g., electrolysis of water*)

Skill Outcomes (focus on scientific inquiry)

Initiating and Planning

Students will:

Ask questions about relationships between and among observable variables, and plan investigations to address those questions

- define questions and problems to facilitate investigation (*e.g., ask how a mixture of salt and water could be separated into its components*)
- state a prediction and a hypothesis based on background information or on an observed pattern of events (*e.g., apply knowledge of the properties of elements to place them on a periodic table*)
- formulate operational definitions of major variables and other aspects of their investigations (*e.g., identify selected solutions and pure substances on the basis of their properties*)
- design an experiment, and identify major variables (*e.g., investigate and classify elements as metals or nonmetals; test various detergents for effectiveness; identify factors that cause corrosion in iron*)
- select appropriate methods and tools for collecting data and information to solve problems (*e.g., separate a mixture using standard techniques, such as filtration, evaporation, crystallization or chromatography*)

Performing and Recording

Students will:

Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data

- carry out procedures, controlling the major variables (*e.g., investigate properties, such as physical appearance, density, conductivity, solubility, magnetism and melting point, of sample materials in the laboratory and in a reference source, and tabulate the results*)
- organize data, using a format that is appropriate to the task or experiment (*e.g., prepare a chart that describes the properties of common household solutions and lists procedures for their safe use, storage and disposal*)
- select and integrate information from various print and electronic sources or from several parts of the same source (*e.g., use current, reliable information sources to investigate elements and compounds; upload and download text, image, audio and video files on the safe handling of chemicals in the workplace*)

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- use or construct a classification key (*e.g., identify selected acid and base solutions on the basis of their properties*)
- predict the value of a variable, by interpolating or extrapolating from graphical data (*e.g., use data collected by computer in the laboratory or by other means to demonstrate that the solubility of substances varies directly with the temperature*) [**Prerequisite Skill: Grade 7 Mathematics, Patterns and Relations, Specific Outcome 2; Related Skill: Mathematics 14, Patterns and Relations, Specific Outcome 2**]

- interpret patterns and trends in data, and infer and explain relationships among the variables (*e.g., use data collected by computer in the laboratory or by other means to demonstrate that the solubility of substances varies with the nature of the solute and the solvent*) [**Prerequisite Skill: Grade 7 Mathematics, Statistics and Probability, Specific Outcome 5; Related Skill: Mathematics 14, Statistics and Probability, Specific Outcome 3**]
- identify potential sources of error in the measurement (*e.g., analyze the use of colour to estimate the concentration of a solution*)
- state a conclusion based on experimental data, and explain how evidence gathered supports or refutes the initial hypothesis (*e.g., observe the chemical and physical properties of metals and nonmetals, and explain how these observations support the classification system for metals, nonmetals and metalloids*)
- identify and evaluate potential applications of findings (*e.g., relate the use of standard laboratory separation techniques to the processes used in water treatment and purification; investigate how soaps and detergents can dissolve in both water and oil*)

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- receive, understand and act on the ideas of others (*e.g., share information and learn from others*)
- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means (*e.g., write a paragraph to describe how chemicals are used at home and in industry*)

Attitude Outcomes

Interest in Science

Students will be encouraged to:

Show interest in science-related questions and issues, and confidently pursue personal interests and career possibilities within science-related fields (*e.g., research answers to questions, such as: "What is the pH of the shampoo and other cleaning solvents used in my home?"*; recognize that part-time jobs require science- and technology-related knowledge and skills)

Mutual Respect

Students will be encouraged to:

Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (*e.g., appreciate how scientific problem solving and the development of new technologies are related; recognize the contribution of science and technology to the progress of civilizations*)

Scientific Inquiry

Students will be encouraged to:

Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (*e.g., critically evaluate inferences and conclusions; ask questions and do research to ensure personal understanding*)

Collaboration

Students will be encouraged to:

Work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas (*e.g., work cooperatively with any classmate or group, and share responsibility for any errors made or any difficulties encountered by the group*)

Stewardship

Students will be encouraged to:

Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment (*e.g., assume part of the collective responsibility for the impact of humans on the environment; consider the impact of technologies, weighing scientific, technological and ecological factors; evaluate the long-term impact of waste disposal, such as paints and cleaning solutions, on the environment and the quality of life of living organisms*)

Safety

Students will be encouraged to:

Show concern for safety in planning, carrying out and reviewing activities (*e.g., read the label on materials before using them; interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood; seek assistance immediately for any first-aid concerns, such as cuts, burns or unusual reactions*)

Unit B: Understanding Energy Transfer Technologies (Science and Technology Emphasis)

Overview: Energy can be transferred by means of heat and by use of force or distance multipliers called machines. The optimal design of such energy transfer technologies is based upon an understanding of energy transfer, heat and temperature, and force. Students will gain an understanding that the design of energy transfer technologies also takes into consideration the need for safety and for efficiency as a means of reducing reliance upon nonrenewable energy resources.

Focusing Questions: How do common energy transfer technologies work in meeting our daily needs? Why are efforts to promote energy conservation, by improving the efficiency of these technologies, important to society?

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade/course levels. The intended level and scope of treatment is defined by the outcomes below.

- cooling and heating systems based on radiation, convection, conduction
- particle model of matter, temperature, thermal energy and heat
- methods to reduce the loss of heat from buildings, our bodies and constructed devices
- specific heat capacity
- protection against thermal energy transfer
- simple machines as force or distance multipliers that transfer energy
- energy transfer (work), force and distance
- reducing reliance on nonrenewable energy sources

Outcomes for Science, Technology and Society (STS) and Knowledge

Students will:

1. Describe how natural and technological cooling and heating systems are based upon the transfer of thermal energy (heat) from hot to cold objects
 - observe and explain the functioning of cooling systems as applications that are based on the principle that heat is transferred from hot to cold objects (*e.g., fins on engines, piping on the back of refrigerators and air conditioners, automobile radiators*) [related to learnings/applications in CTS courses ENM2090: Energy Designs/Systems 1 (Basic Principles) and ENM3090: Energy Designs/Systems 2 (Practical Applications)]
 - describe the three ways; i.e., radiation, conduction and convection, that thermal energy is transferred from hot to cold objects
 - describe the particle model of matter in which every object consists of particles in motion, and describe the effect of temperature on this motion (*e.g., observe Brownian motion*)
 - describe the role of convection and conduction in distributing heat in natural and technological systems (*e.g., sea and land breezes, convection ovens, metal pipes, cast-iron pots and pans*)
 - explain how large bodies of water, such as oceans and lakes, have a moderating influence on climate (*e.g., compare the climates of Vancouver and Calgary*)
2. Explain the functioning of common methods and devices designed to control the transfer of thermal energy
 - explain the functioning of technologies that reduce thermal energy transfer (*e.g., clothing, construction strategies for reducing heat loss—insulation, cavity walls, aluminum foil and double glazing*) [related to learnings/applications in CTS course CON3080: Energy-efficient Housing]
 - describe the functioning of devices and methods that protect against potentially dangerous thermal energy transfer (*e.g., household appliances, protective clothing worn by firefighters,*

internal combustion engine) [related to learnings/applications in CTS courses ENM2090: Energy Designs/Systems 1 (Basic Principles), ENM3090: Energy Designs/Systems 2 (Practical Applications) and MEC2030: Lubrication & Cooling]

- describe the variation in absorption/loss of heat (specific heat capacity) of a substance being heated or cooled, by manipulating variables that include the amount and type of material (*e.g., motor oil, cooking oil, water*)
3. Describe and compare simple machines as devices that transfer energy and multiply forces or distances
- analyze and describe simple machines as devices that transfer energy (*e.g., screws, ramps, hammers, hockey sticks, tennis rackets*)
 - identify the joule and the newton metre as the units of energy and work in the International System of Units (SI)
 - analyze and describe simple machines as either force multipliers or distance multipliers
 - describe all simple machines as having an input force, an output force and a fulcrum (*e.g., pulleys, doorknobs, winches*)
 - develop the relationship Fd , by measuring the force (F) applied to the object and the distance (d) the object is moved in the direction in which the force is applied (*e.g., use a balance beam [teeter-totter] to establish equilibrium, placing differing masses at various distances*)
[Prerequisite Skill: Grade 7 Mathematics, Patterns and Relations, Specific Outcome 5; Related Skill: Mathematics 14, Patterns and Relations, Specific Outcome 1]
 - explain the functioning of common household machines, in terms of force multipliers and ways in which work is made easier (*e.g., can openers, crowbars, car jacks, scissors and hedge clippers*)
 - explain the need to encourage and support the development of machines that are efficient and rely upon renewable energy sources (*e.g., hand-wound radios, solar-powered calculators, solar cookers*) [related to learnings/applications in CTS course ENM1050: Renewable Resources]

Skill Outcomes (focus on problem solving)

Initiating and Planning

Students will:

Ask questions about relationships between and among observable variables, and plan investigations to address those questions

- rephrase questions in a testable form, and clearly define practical problems (*e.g., "How is the human body analogous to a machine?"*)
- identify questions to investigate arising from practical problems and issues (*e.g., investigate the functioning of common machines, such as car jacks, can and bottle openers, meat grinders, bicycles, ramps and others, that either change the direction, speed or magnitude of a force*)
- propose alternative solutions to a given practical problem, select one, and develop a plan (*e.g., identify ways to reduce thermal energy loss or gain in school buildings*)
- state a prediction and a hypothesis based on background information or on an observed pattern of events (*e.g., hypothesize the relationship between the rate of thermal conduction in different materials and their insulative properties*)
- design an experiment, and identify major variables (*e.g., design an experiment to compare temperature changes in different liquids as they are heated, identifying variables and controls; write a procedure, design the observation tables or charts, and identify possible sources of error and their effects on the results*)

Performing and Recording

Students will:

Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data

- estimate measurements (*e.g., predict the final temperature when two samples of water at different temperatures are combined*) [Prerequisite Skill: Grade 7 Mathematics, Number, Specific Outcome 14; Related Skill: Mathematics 14, Number, Specific Outcome 4]
- use instruments effectively and accurately for collecting data (*e.g., collect data on daily household energy consumption by recording electricity and gas meter readings over a two-week period; organize, display and analyze the data*) [Prerequisite Skills: Grade 7 Mathematics, Statistics and Probability, Specific Outcomes 4 and 5; Related Skills: Mathematics 14, Statistics and Probability, Specific Outcomes 3 and 5]
- use tools, technology and apparatus safely (*e.g., build a container to keep material hot or cold; safely perform an experiment to compare the thermal conduction rate of different materials*)

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- interpret patterns and trends in data, and infer and explain relationships among the variables (*e.g., suggest the reasons for daily fluctuations in domestic energy consumption*)
- calculate theoretical values of a variable (*e.g., calculate energy transferred [work, W], force [F] or distance [d], when two quantities and the equation $W = Fd$ are given; use SI units and unit analyses*) [Prerequisite Skill: Grade 7 Mathematics, Patterns and Relations, Specific Outcome 6; Related Skill: Mathematics 14, Patterns and Relations, Specific Outcome 4]
- identify and evaluate potential applications of findings (*e.g., perform an experiment to investigate how well various materials insulate; graph temperature changes; rank commonly available insulating materials from the most to the least effective, for constructing a heat-retaining device*)
- test the design of a constructed device or system (*e.g., construct a model wall, roof, floor or window to test the effectiveness of several methods of insulating homes; evaluate insulating materials, such as brick, stone, straw, wood or paper*)
- identify and correct practical problems in the way a prototype or constructed device functions (*e.g., analyze a device constructed to use solar energy for cooking*)
- evaluate designs and prototypes in terms of function, reliability, safety, efficiency, use of materials and impact on the environment (*e.g., test insulating materials and methods; determine the efficiency of a machine*)

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- receive, understand and act on the ideas of others (*e.g., revise laboratory reports based on feedback from others*)
- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means (*e.g., draw diagrams that show the differences between particles in solids, liquids and gases; communicate using the terms*

thermal energy, temperature and specific heat capacity; observe and accurately record the movement of dye in a convection tank)

Attitude Outcomes

Interest in Science

Students will be encouraged to:

Show interest in science-related questions and issues, and confidently pursue personal interests and career possibilities within science-related fields (*e.g., explore and use a variety of methods and resources to increase knowledge and skills and to solve problems; recognize that part-time jobs require science- and technology-related knowledge and skills*)

Mutual Respect

Students will be encouraged to:

Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (*e.g., recognize that the modern western approaches to technology are not the only ways by which people, such as Aboriginals, have met their needs*)

Scientific Inquiry

Students will be encouraged to:

Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (*e.g., ask questions and do research to ensure understanding*)

Collaboration

Students will be encouraged to:

Work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas (*e.g., seek the point of view of others, and consider a multitude of perspectives; accept constructive criticism when sharing ideas or points of view; evaluate the ideas of peers*)

Stewardship

Students will be encouraged to:

Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment (*e.g., promote actions and technologies that are not injurious to the environment; consider the impact of technology, weighing scientific, technological and ecological factors*)

Safety

Students will be encouraged to:

Show concern for safety in planning, carrying out and reviewing activities (*e.g., keep the work station uncluttered, with only appropriate materials present; consider safety a positive limiting factor in scientific and technological endeavours*)

Unit C: Investigating Matter and Energy in Living Systems (Science and Technology Emphasis)

Overview: Life processes require the exchange of matter between living systems and the external environment. Students will investigate life processes at the organism and system level, and extrapolate these processes to the cellular level. In closely studying the digestive and circulatory systems, students will understand that a healthy diet and lifestyle is crucial to their wellness.

Focusing Questions: What lifestyle choices can be made to help our organs and organ systems function optimally? How do cells, which are microscopic and invisible to the naked eye, work together in organs and organ systems to carry out life functions?

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade/course levels. The intended level and scope of treatment is defined by the outcomes below.

- structures and functions of, and the relationship between, the digestive and circulatory systems
- diets and human nutritional needs
- social influences on human dietary-induced disorders and circulatory diseases
- microscopy, structure and function of plant and animal cell parts, and the cell theory
- life functions common to living systems
- functions of cells in organs and organ systems
- photosynthesis and respiration
- capture, storage and use of energy by living organisms
- role of technology to monitor life functions

Outcomes for Science, Technology and Society (STS) and Knowledge

Students will:

1. Describe, in general terms, the exchange of matter by the digestive and circulatory systems, the functional relationship between the two systems and the need for a healthy diet and lifestyle
 - assess the nutrient components of prepared foods by reading labels, and evaluate a variety of popular diets in terms of nutrient composition [related to learnings/applications in CTS courses CMH1080: Perspectives on Health, FOD2010: Food & Nutrition Basics and FOD2130: Vegetarian Cuisine]
 - explain, in general terms, how diets that include excessive amounts of certain foods may influence body function (*e.g., cholesterol, salt, fats*) [related to learnings/applications in CTS courses CMH1080: Perspectives on Health, FOD2010: Food & Nutrition Basics and FOD2130: Vegetarian Cuisine]
 - analyze and discuss mixed diets and vegetarian diets in meeting human nutritional needs [related to learnings/applications in CTS courses CMH1080: Perspectives on Health, FOD2010: Food & Nutrition Basics and FOD2130: Vegetarian Cuisine]
 - describe, in general terms, the intake of matter and its processing by the digestive system (*e.g., foods are broken down into molecules that are absorbed into the blood stream from the intestine; food intake leads to increased blood sugar and mineral levels*)
 - describe, in general terms, the role of the heart and lungs in the circulatory system and in the exchange and distribution of matter processed by the digestive system
 - analyze the functional relationship between the digestive and circulatory systems, recognizing the work of early physicians (*e.g., William Harvey, Ivan Pavlov, William Beaumont*) [related to learnings/applications in CTS course CMH3080: Digestive System]

2. Describe disorders of the digestive and circulatory systems as imbalances induced by genetic, lifestyle and environmental factors
 - describe, in general terms, how the digestive and circulatory systems interact to assist in the maintenance of balance (homeostasis) in the human organism
 - explain how normal fluctuations within the digestive system result in adjusting fluctuations in the circulatory system (*e.g., ingestion of salt and increased blood pressure; the relationship between blood sugar and insulin production*)
 - explain that illness and possibly death may result when the body cannot accommodate major disturbances within a system; i.e., digestive, excretory or circulatory (*e.g., ulcers, heart attacks*) **[related to learnings/applications in CTS course CMH3080: Digestive System]**
 - analyze and explain, in general terms, a technology that is used to diagnose imbalances (*e.g., endoscope, stethoscope*) or to intervene and preserve balance (homeostasis) (*e.g., kidney dialysis machine, pacemaker*) **[related to learnings/applications in CTS course CMH3110: Advances in Medical Technology]**
 - evaluate the effect of social factors on human digestive and circulatory well-being and disorders (*e.g., ulcers, anorexia, bulimia, high blood pressure, heart and arterial diseases as they relate to lack of fitness, unbalanced diets*) **[related to learnings/applications in CTS courses CMH1080: Perspectives on Health and FOD2030: Food Decisions & Health]**

3. Describe, in general terms, the structure and function of plant and animal cell parts; and trace the development of the cell theory
 - relate human knowledge of cells to the development of the optical microscope and staining techniques (*e.g., the work of Antony van Leeuwenhoek, Robert Hooke*)
 - describe the structure of the major parts of plant and animal cells, including the cell membrane, nucleus, vacuole, mitochondrion, chloroplast and cell wall
 - describe, using analogies where appropriate, the functions of the major parts of plant and animal cells, including the cell membrane, nucleus, vacuole, mitochondrion, chloroplast and cell wall (*e.g., compare cell functions to the functioning of a city*)

4. Identify and compare, in general terms, the life functions common to living systems, from cells to organ systems
 - describe the relationship between photosynthesis and cellular respiration in terms of biological energy storage; i.e., capture of energy from the Sun in glucose during photosynthesis, and the release of energy from glucose during respiration
 - identify life functions common to living systems; i.e., energy conversion, response to the environment, growth, reproduction, and conservation or dissipation of thermal energy (*e.g., torpor, dormancy, hibernation, estivation, vascular skin, sweat gland behaviour*)
 - identify organs and systems in plants and animals that carry out the above life functions
 - identify the major human organ systems that perform critical life functions; i.e., energy conversion, response to the environment, growth, reproduction, and conservation or dissipation of thermal energy
 - describe how cell structure has been adapted for specific life functions (*e.g., stomata in the leaves for water balance; skin cells are flat to cover large surface area; plant cell walls provide structural support; nerve cells are long for transmission of impulses; storage of chemical energy in roots [e.g., sugar beets], stems [e.g., sugar cane] and fruits [e.g., apples]*)
 - identify and describe the role of modern technology in monitoring critical life functions in humans (*e.g., ultrasound, heart monitor, blood pressure cuff, blood glucose monitoring devices*) **[related to learnings/applications in CTS course CMH3110: Advances in Medical Technology]**

Skill Outcomes (focus on problem solving)

Initiating and Planning

Students will:

Ask questions about relationships between and among observable variables, and plan investigations to address those questions

- rephrase questions in a testable form, and clearly define practical problems (e.g., *"Is there a relationship between social attitudes and diet?"*, *"What design features would a device have in order to listen to a heart beat?"*)
- identify questions to investigate arising from practical problems and issues (e.g., *plan and conduct a search, using a wide variety of electronic sources, when investigating technology used to monitor critical life functions*)
- propose alternative solutions to a given practical problem, select one, and develop a plan (e.g., *build a device that magnifies objects or monitors human health; investigate the use of herbal and over-the-counter remedies to decrease symptoms of human diseases/disorders/imbalances*)

Performing and Recording

Students will:

Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data

- carry out procedures, controlling the major variables (e.g., *perform experiments that demonstrate diffusion rate, and communicate this information graphically; identify the manipulated, responding and controlled variables for an experimental investigation of the effect of exercise on heart rate*)
- estimate measurements (e.g., *calculate the magnification from knowledge of the microscope*)
[Prerequisite Skills: Grade 8 Mathematics, Number, Specific Outcome 12 and Shape and Space, Specific Outcome 11; Related Skill: Mathematics 14, Number, Specific Outcome 11]
- use instruments effectively and accurately for collecting data (e.g., *prepare wet mounts of tissue, and observe cellular structures specific to plant cells and animal cells; observe structures using photomicrographs or electron micrographs*)
- organize data, using a format that is appropriate to the task or experiment (e.g., *determine the nutrient components in popular diets*)
- select and integrate information from various print and electronic sources or from several parts of the same source (e.g., *use models, computer simulations or dissected organisms to observe the gross anatomy of human body systems [this requires that students have a general understanding of the system anatomy but does not require detailed knowledge and terminology of each of the systems]*)
- use tools and apparatus safely (e.g., *stain a variety of animal and plant cells, use the compound microscope to identify cellular structures from prepared slides of plant and animal tissue or from microslides, and accurately represent these structures in clearly labelled diagrams*)

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea (e.g., *observe cytoplasmic streaming in the paramecium, and compare this*

method of matter distribution to that in multicellular living systems, such as the human organism; observe the feeding behaviour of paramecium, and compare this to the processes that occur in the human organism)

- critique the design of a constructed device or system (e.g., *model of cell, stethoscope*)
- identify and correct problems in the way a prototype or constructed device functions (e.g., *analyze models of organs that perform a specific function*)
- evaluate designs and prototypes in terms of function, reliability, safety, efficiency, use of materials and impact on the environment (e.g., *a device built to monitor life functions*)
- identify new questions and problems that arise from what was learned (e.g., *"How do water and dissolved materials move in living plant and animal cells?"*)

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- receive, understand and act on the ideas of others (e.g., *revise designs of prototypes, based on the feedback of others*)
- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means (e.g., *research and identify the cause and physiological basis of a specific disorder in one of the systems studied; present this information orally to peers or in a document, using style sheets and with attention to page layout that incorporates advanced word processing techniques, including headers, footers, margins, columns, bibliography, index, table of contents*)
- defend a given position on an issue or problem, based on their findings (e.g., *research how individual lifestyles [such as smoking, inactivity, stress] and eating habits [such as high fat diet] affect the functioning of the circulatory system; take a position on whether individuals should or should not be coerced into healthier lifestyles*)

Attitude Outcomes

Interest in Science

Students will be encouraged to:

Show interest in science-related questions and issues, and confidently pursue personal interests and career possibilities within science-related fields (e.g., *research the answers to their own questions; readily investigate ways to improve the functioning of the circulatory and digestive systems*)

Mutual Respect

Students will be encouraged to:

Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., *recognize the contribution of science and technology to the progress of civilizations; use a multi-perspective approach, considering scientific, technological, economic, cultural, political and environmental factors, when formulating conclusions on the impact of western/nonwestern diets on human health*)

Scientific Inquiry

Students will be encouraged to:

Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (*e.g., insist that the critical assumptions behind any line of reasoning be made explicit, so that the validity of the solution can be judged; criticize arguments in which evidence, explanations or positions do not reflect the diversity of perspectives that exist*)

Collaboration

Students will be encouraged to:

Work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas (*e.g., provide the same attention and energy to the group's product as to a personal assignment; evaluate the ideas of peers*)

Stewardship

Students will be encouraged to:

Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment (*e.g., consider all perspectives when addressing issues, weighing scientific, technological and ecological factors*)

Safety

Students will be encouraged to:

Show concern for safety in planning, carrying out and reviewing activities (*e.g., keep the work station uncluttered, with only appropriate materials present*)

Unit D: Investigating Matter and Energy in the Environment (Social and Environmental Emphasis)

Overview: Energy from the Sun sustains living systems and maintains equilibrium in the biosphere. In the biosphere, matter is recycled along natural pathways. However, the increasing human population, human activity, and increasing human use of energy and reliance on manufactured materials are having an impact on the movement of matter and energy in the biosphere. This raises global concerns about sustainability.

Focusing Questions: How is human activity influencing the natural flow of matter and energy in the biosphere? Should humans as a species be concerned about the effects of their activities on other species and the environment?

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade/course levels. The intended level and scope of treatment is defined by the outcomes below.

- role of living organisms in cycling matter
- flow of energy through the biosphere
- food chains, food webs and energy pyramids
- maintaining equilibrium in the biosphere
- recycling of human-generated wastes
- biodegradable materials
- impact of modern agricultural technologies
- biotic and abiotic factors and ecosystems
- field study of ecosystems
- factors affecting population growth
- human impact on ecosystems

Outcomes for Science, Technology and Society (STS) and Knowledge

Students will:

1. Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity
 - explain the role of living systems in the cycling of matter in the biosphere (*e.g., food chains*)
 - assess the costs and benefits of technological developments that produce materials the ecosystem cannot recycle (*e.g., disposable plastics, heavy metals*) [related to learnings/applications in CTS course ENM1090: Fundamentals of Recycling]
 - explain how biodegradable materials reduce the impact of human-made products on the environment [related to learnings/applications in CTS course ENM1090: Fundamentals of Recycling]
 - describe, in general terms, how water, carbon, oxygen and nitrogen are cycled through the biosphere [related to learnings/applications in CTS course AGR3110: Water Management]
 - explain why the flow of energy through the biosphere is linear and noncyclical
 - compare the recycling of matter by society with the natural cycling of matter through ecosystems [related to learnings/applications in CTS course ENM1090: Fundamentals of Recycling]
 - assess the impact of modern agricultural technology on the natural pathways of recycling matter [related to learnings/applications in CTS course AGR1100: Agriculture Technology]
 - identify and assess the needs and interests of society that have led to technologies with unforeseen environmental consequences (*e.g., fishing technologies that result in harvesting more than the rate of reproduction, use of pesticides such as DDT, impact of driving a car on atmospheric compositions*) [related to learnings/applications in CTS courses LGS2030: Environmental Law and WLD1050: Taking Responsibility (People, Culture & Wildlife)]

2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium
- describe, in general terms, the characteristics of two Alberta biomes (*e.g., parkland, boreal forest, mountain, grassland*) [related to learnings/applications in CTS course WLD2040: **Wildlife Spaces & Species**]
 - define ecosystems in terms of biotic and abiotic factors (*e.g., common plants and animals, latitude, altitude, topography*)
 - describe how various abiotic factors influence biodiversity in an ecosystem (*e.g., climate, substrate, temperature, elevation*) [related to learnings/applications in CTS course WLD1010: **What Is Wildlife?**]
 - explain how biotic relationships can be explained in terms of the movement of matter and energy, using food chains, food webs and energy pyramids [related to learnings/applications in CTS course WLD1010: **What Is Wildlife?**]
 - explain how various factors influence the size of populations; i.e., immigration and emigration, birth and death rates, food supply, predation, disease, reproductive rate, number of offspring produced, and climate change
 - describe how interactions among organisms limit populations (*e.g., predation, parasitism, competition*) [related to learnings/applications in CTS course WLD1020: **Natural History of Wildlife**]
 - assess the impact of the introduction of exotic species on a specific ecosystem or biome (*e.g., purple loosestrife in western Canadian wetlands, English sparrows in North America, zebra mussels in the Great Lakes*)
 - describe the relationship between land use practices and altering ecosystems (*e.g., swamp drainage, slash and burn forestry, agriculture*) [related to learnings/applications in CTS courses AGR3010: **Issues in Agriculture** and WLD2060: **Interactions (Wildlife & Society)**]
 - trace the development of a technological application that has altered an ecosystem (*e.g., power generation, fishing, logging, oil and gas exploration, agricultural practices*) [related to learnings/applications in CTS courses ENM1050: **Renewable Resources** and ENM3010: **Energy & the Environment**]

Skill Outcomes (focus on the use of research and inquiry skills to inform the decision-making process)

Initiating and Planning

Students will:

Ask questions about relationships between and among observable variables, and plan investigations to address those questions

- identify questions to investigate arising from practical problems and issues (*e.g., develop questions related to recycling, ozone depletion or introduction of exotic species*)
- define questions and problems to facilitate investigation (*e.g., develop questions to guide investigations on composting, recycling, impact of farming practices on local ecosystems*)
- design an experiment; and identify the manipulated, responding and controlled variables (*e.g., investigate the amount of waste materials produced by a school or family on a daily or weekly basis*)
- select appropriate methods and tools for collecting data and information to solve problems (*e.g., plan and conduct a search for environmental projects, using a wide variety of electronic sources*) [Prerequisite Skill: **Grade 8 Mathematics, Statistics and Probability, Specific Outcome 2**]

Performing and Recording

Students will:

Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data

- carry out procedures, controlling the major variables (*e.g., perform quantitative experiments to demonstrate that cellular respiration releases some thermal energy*)
- estimate measurements (*e.g., collect quantitative data that demonstrate how closed populations of organisms—hay infusions, pond water samples, fruit flies, brine shrimp—change over time; present the data in tables, graphs or charts*) [**Related Skills: Mathematics 14, Shape and Space, Specific Outcomes 1 and 2**]
- organize data, using a format that is appropriate to the task or experiment (*e.g., analyze the biotic and abiotic data collected in an ecosystem study, and present this information in a written or graphic format or in an oral presentation to peers*) [**Prerequisite Skills: Grade 7 Mathematics, Patterns and Relations, Specific Outcome 3 and Grade 8 Mathematics, Statistics and Probability, Specific Outcome 2**]
- select and integrate information from various print and electronic sources (*e.g., research the influence of a specific living organism—nitrogen bacteria, sulfur bacteria, sea birds, mollusks—on the cycling of matter through the biosphere, and communicate information in the form of a clearly written report; create a database or use spreadsheets to convey information on populations*)
- use tools, technology and apparatus safely (*e.g., use computer-based learning or other means to perform a field study on an aquatic or terrestrial ecosystem; measure, quantitatively, appropriate abiotic data—temperature, humidity, precipitation, light intensity, pH, hardness, dissolved oxygen content*) [**Related Skill: Mathematics 14, Statistics and Probability, Specific Outcome 2**]

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs and scatterplots (*e.g., analyze population growth curve graphs; communicate information on the flow of energy through the biosphere, using a diagram or flow chart*) [**Prerequisite Skill: Grade 8 Mathematics, Statistics and Probability, Specific Outcome 3; Related Skill: Mathematics 14, Patterns and Relations, Specific Outcome 2**]
- identify strengths and weaknesses of different methods of collecting and displaying data (*e.g., analyze methods used to collect and display biotic and abiotic data for an ecosystem*)
- apply given criteria for evaluating evidence and sources of information (*e.g., discuss whether extinction is a natural phenomenon; assess the authority and reliability of print and electronic sources on the basis of provided criteria*)
- state a conclusion, based on experimental data; and explain how evidence gathered supports or refutes an initial idea (*e.g., explain, on the basis of experimental evidence, how energy is stored in the form of starch in photosynthetic organisms*)
- identify and evaluate potential applications of findings (*e.g., experimentally determine the biodegradability of various forms of organic matter, and relate findings to composting and recycling*)
- identify new questions and problems that arise from what was learned (*e.g., "Should there be more controls on bringing live animals and plants to Canada from the United States and other countries?", "How can we reduce the amount of household wastes?"*)

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- receive, understand and act on the ideas of others (*e.g., revise text documents based on feedback from others*)
- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means (*e.g., represent the movement of matter and energy in an ecosystem, using food chains, webs or pyramids, and communicate this information in the form of a graphic illustration; describe the biogeochemical cycles of carbon, nitrogen or oxygen, and communicate this information in clearly labelled charts, models or diagrams*)
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (*e.g., perform a field study on an aquatic or terrestrial ecosystem*)
- evaluate individual and group processes used in planning, problem solving, decision making and completing a task (*e.g., evaluate group brainstorming ideas for environmental projects*)
- defend a given position on an issue or problem, based on their findings (*e.g., investigate reduction of household wastes, or investigate ways to prevent the introduction of exotic species into Alberta or Canada*)

Attitude Outcomes

Interest in Science

Students will be encouraged to:

Show interest in science-related questions and issues, and confidently pursue personal interests and career possibilities within science-related fields (*e.g., demonstrate an interest in science and technology topics not directly related to classroom studies; readily investigate Science, Technology and Society issues*)

Mutual Respect

Students will be encouraged to:

Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (*e.g., consider scientific, technological, economic, cultural, political and environmental factors when formulating conclusions, solving problems or making decisions on a Science, Technology and Society issue*)

Scientific Inquiry

Students will be encouraged to:

Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (*e.g., insist on evidence before accepting a new idea or explanation for waste reduction; insist that the critical assumptions behind any line of reasoning be made explicit, so that the validity of the position taken can be judged*)

Collaboration

Students will be encouraged to:

Work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas (*e.g., be attentive when others speak; suspend personal views when evaluating suggestions made by a group; be nonjudgmental in the discussion of ideas and plans*)

Stewardship

Students will be encouraged to:

Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment (*e.g., examine their personal role in the preservation of the environment; make personal decisions based on feelings of responsibility toward less privileged parts of the global community and toward future generations; participate in the social and political systems that influence environmental policy in their community*)

Safety

Students will be encouraged to:

Show concern for safety in planning, carrying out and reviewing activities (*e.g., consider safety and show concern for the environment when disposing of used materials*)

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